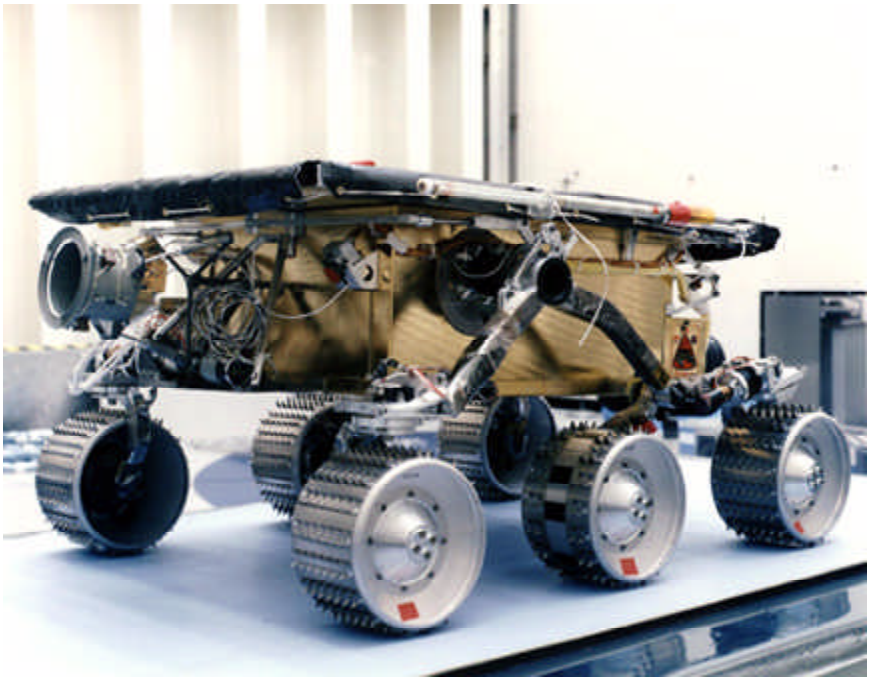
Wheel Abrasion Experiment Conducted on Mars



Sojourner rover showing Lewis' wheel abrasion experiment.

The Mars Pathfinder spacecraft soft-landed on Mars on July 4, 1997. Among the many experiments on its small Sojourner rover are three technology experiments from the NASA Lewis Research Center, including the Wheel Abrasion Experiment (WAE). The WAE was designed, built, delivered, and operated on Mars by a team of engineers and scientists from Lewis' Photovoltaics and Space Environments Branch. This experiment collected data to assess wheel surface wear on the Sojourner. It used a specially designed rover wheel, with thin films (200 to 1000 angstroms) of aluminum, nickel, and platinum deposited on black, anodized aluminum strips attached to the rover's right center wheel. As the wheel spun in the Martian soil, a photovoltaic sensor monitored changes in film reflectivity. These changes indicated abrasion of the metal films by Martian surface material. Rolling wear data were accumulated by the WAE. Also, at frequent intervals, all the rover wheels, except the WAE test wheel, were locked to hold the rover stationary while the test wheel alone was spun and dug into the Martian regolith. These tests created wear conditions more severe than simple rolling.

The WAE will contribute substantially to our knowledge of Martian surface characteristics. Marked abrasion would indicate a surface composed of hard, possibly sharply edged grains, whereas lack of abrasion would suggest a somewhat softer surface. WAE results will be correlated with ground simulations to determine which terrestrial materials behave most like those on Mars. This knowledge will enable a deeper understanding of erosion processes on Mars and the role they play in Martian surface evolution.

Preliminary results show that electrostatic charging of the rover wheels sometimes caused dust to accumulate on the WAE wheel, making interpretation of the reflectance data problematic. If electrostatic charging is the mechanism for dust attraction, this indicates that the Martian dust has a size somewhat smaller than 40 μm in diameter. The WAE experiment has detected electrostatic charging in the Martian environment for the first time; however, under conditions when the wheel is relatively clean of Martian dust, flight data now indicate that abrasion has also been detected. Crude limits so far place the hardness of the Martian dust at harder than aluminum but softer than nickel, and place the grain size at somewhat smaller than 40 μm.

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